

A BIOLOGICAL STUDY OF *LYGAEUS KALMII* STÅL (HEMIPTERA-LYGAEIDAE).

BY WILLIAM A. SIMANTON* AND FLOYD ANDRE (Co-authorship).

From the Department of Zoology and Entomology, Iowa State
College, Ames, Iowa.

INTRODUCTION.

While making a search for an hemipterous insect suitable for experimental work in the laboratory, the writers became interested in a rather large lygaeid known as *Lygaeus kalmii* Stål. As this species appeared to be a desirable form to use in studying problems of insect physiology and toxicology (Simanton and Andre, 1935), a large number were reared for experimental purposes. A review of the literature revealed that very little is known concerning the habits of the various species of the genus *Lygaeus*. During the past three years both field and laboratory studies were conducted on the life history and ecological relationships of this species. The data and observations obtained during this period, together with a description of the life stages are presented in this paper.

RELATIONSHIPS AND HISTORICAL.

Lygaeus kalmii belongs to the hemipterous family Lygaeidae and to the subfamily Lygaeinae. The genus, *Lygaeus*, contains a number of species, so much alike morphologically that color markings are used to a great extent in separating the various species. This has resulted in much controversy upon the precise nomenclature of certain forms, especially since some of the species in question show rather wide color variations. The particular species here concerned is an example of such intra-specific color variation. Indeed, the question has arisen whether *Lygaeus kalmii* should be separated into varieties or into two distinct species (Van Duzee 1923, Parshley 1923, 1924). For the most part the writers have dealt with these as the same species in the present paper and have not separated them into varieties, although some data have been collected that might be employed in a varietal separation.

Numerous other citations appear in the literature which deal with collecting records of this species, especially a paper by Townsend (1887) who calls attention to the early papers upon the feed-

* Gulf Research & Development Co., P. O. Box 2038, Pittsburgh, Pa.

ing habits of *L. kalmii* under the name of *Lygaeus turcicus* Fab. and gives some brief notes as to its habits in Michigan.

LIFE HISTORY.

I. NATURAL CONDITIONS.

Food—Under field conditions both nymphs and adults of *L. kalmii* feed on the juices of green milkweed plants during the growing season. In Iowa the species of milkweed most frequented by them are *Asclepias syriaca* L., and *A. verticillata* L. However, during the late fall and early spring these insects have the ability to survive on the matured seeds, and dehisced pods of milkweed plants.

The Eggs—The ova of *L. kalmii* are deposited in the field in various situations depending on the season of the year. Egg deposition begins in the vicinity of Ames, Iowa, early in April shortly after the overwintering adults become active. The females may deposit their ova in fallen milkweed pods or leaves or they may drop them promiscuously on the ground. Sometimes the eggs are partly inserted in the cottony material of the old pods, and may be deposited singly or in groups of 30 or more.

As the weather becomes warmer and after the milkweeds have grown to considerable size the eggs are often deposited in masses on the leaves or about the pods of the growing plants. They are not, so far as we can ascertain, inserted in the plant tissue.

The Nymphs—The nymphs of *Lygaeus kalmii* begin moving about soon after they hatch. They are noticeably gregarious in habit, however, and tend to gather into more or less small aggregations. Nymphs in the field during the early spring feed on the old pods, stems, and seeds of dead milkweed plants. Some have been observed to suck the stems of bluegrass, apparently in an effort to secure moisture. Later in the season the nymphs feed almost entirely on the juices of growing milkweeds.

If one approaches a plant on which nymphs are feeding, they will drop to the ground and scatter in all directions, a characteristic no doubt which helps to protect them from their predators.

There are five nymphal instars during the development of *L. kalmii*. Preceding each there is a short quiescent period, lasting for from 5 to 10 minutes. During ecdysis the skin ruptures along the dorsal line, the split reaching from the eyes to the second segment of the abdomen. The whole molting period lasts for about 20 minutes, and at this time the nymph is in a very helpless condi-

tion and at the mercy of its predators as well as of members of its own species which not infrequently show cannibalistic tendencies.

The Adults—Adults may be found at all seasons of the year. With the advent of warm weather in the spring, mating and egg-laying begin and one may find gravid females from early April to the middle of October. Adults taken as late as November 1 have started to mate and to lay eggs within two weeks after being brought into the laboratory and confined at a temperature of 30° C.

Seasonal Life History—During the growing season of 1933 there were two complete generations and a partial third. This would not be the normal expected thing, however, as we had an unusually warm season, a rather early spring and a late fall; and nymphs in the field were not killed until about Nov. 1.

Briefly, the seasonal life history is as follows: Adults of the second generation pass the winter largely in old patches of milkweed preferring those areas somewhat protected by grasses. Some adults overwinter in dead leaves, trash and fence-rows, and the like. Mating and egg-laying of the over-wintering adults occur early in April. Each female may lay from a few to as many as 1600 eggs. This egg-laying period may extend over a month or more depending on the season. The first new adults appear about the last week in June. Within a few days these mate and begin egg-laying for the second generation which matures during early August. Ordinarily these adults lay a few eggs but nymphs hatching from them do not mature.

LIFE HISTORY IN THE LABORATORY.

For the purpose of studying the bionomic factors of *Lygaeus kalmii*, many cages, some containing individuals and others confining aggregations, were observed under both constant conditions of temperature and humidity and in an out-of-door screened insectary. The investigations at constant conditions were conducted at temperatures of 29.5° C. and 73 per cent relative humidity (saturated sodium chloride solution), 34.5° C. and 76 per cent relative humidity, and in the case of the egg records also at 24.5° C. and 67 per cent relative humidity.

Egg records were obtained from twelve females, four pairs at each of the above temperatures. The cages used were lamp chimneys closed at both ends by means of cheesecloth securely fastened with rubber bands. A number of threshed milkweed seed (*Asclepias syriaca* L. and *A. verticillata* L.), a small vial of water with a cellulocotton plug, and a ball of cotton to serve as a medium for

oviposition were placed in each cage. Only a single pair of bugs was confined in one cage. The yellowish egg masses usually inserted deeply in the cotton were removed daily and the number of eggs recorded. Observations were also taken on the lengths of pre-coital and pre-oviposition periods.

Following a pre-coital period of three days and a pre-oviposition period of about four days, oviposition occurred over an average time of thirty-eight days at 24.5° C., thirty-two days at 29.5° C. and twenty-four days at 34.5° C. The twelve females laid from a minimum of 807 to a maximum of 1482 with an average of 1029 eggs. The average for the four females at 24.5° C. was 1246, for the four females at 29.5° C., 1140, and for the four females at 34.5° C., 1001. The average size of the egg masses was forty-eight eggs.

Information on the time of incubation and duration of nymphal instars was obtained for constant temperatures of 29.5° C., 34.5° C., and under out-of-door conditions. Eggs of known age and source were placed separately in shell vials that were later plugged with cotton. Six or eight milkweed seeds in each vial were sufficient to rear the individual bugs through the five instars. A wad of moistened cellucotton in each vial, renewed at frequent intervals, supplied the necessary water. The following table shows the duration of incubation and nymphal stadia and gives the comparative rate of growth at 29.5° C., and 34.5° C., as well as for out-of-door conditions.

TABLE.
DURATION OF LIFE STAGES OF *L. KALMII* STÅL IN DAYS

Temperature		Egg	First Instar	Second Instar	Third Instar	Fourth Instar	Fifth Instar	Total Egg to Adult
29.5° C. (30 bugs)	Min.	3	3	2	3	3	4	18
	Max.	4	4	4	5	6	6	29
	Ave.	3.5	3.1	3	4	3.5	3.8	20.9
34.5° C. (12 bugs)	Min.	3	2	2	3	3	3	16
	Max.	3	4	4	4	4	3	22
	Ave.	3	3.6	3.1	3.6	3.1	3	19.4
Out-of-door (15 bugs)	Min.	7	6	5	5	5	4	32
	Max.	8	9	9	9	9	9	53
	Ave.	7.5	7.4	6.8	6.8	7.4	6.8	42.7

During the life history studies, records were taken of the sex of each individual reared. The records of 116 adults showed 58 males and 58 females, this being indicative of a 50:50 sex ratio.

DESCRIPTION OF LIFE STAGES.

EGG.

The Egg—The ova are strictly of the lygaeid type and ovoid in outline. When fresh they are straw colored and about 1.21 mm. long and 0.56 mm. wide at the widest portion, which is slightly above the middle. The shell is smooth and without evidence of hexagonal sculpturing and the chorial processes around the upper end are ten in number, small in size, evenly spaced, shaped like an inverted bowl, and concolorous with the remainder of the shell membrane.

INSTARS.

During their development from egg to adult, the nymphs pass through five nymphal instars. A brief description of each follows, and these descriptions have been limited to the variety *angustomarginatus* (dark eastern form).

First Instar—(Fig. 2, Plate V). Shiny, entirely naked, except for numerous fine short hairs on antennae and legs. Antennae and legs grayish brown, except portions separating antennal and the two tarsal segments, which are lighter, and tip of segment 4 of antennae, which is darker. Head, and prothorax brownish, except for lateral margin and mid-dorsal line, which are reddish-orange and concolorous with general body color. Eyes reddish.

Abdomen with lateral margins and two stripes on either side of mid-dorsal reddish area orange-yellow; the other two intervening stripes reddish-orange and concolorous with the mid-dorsal line. Genital spot, repugnatorial glands, and spiracles blackish. Rostrum reaching nearly to the tip of abdomen in newly hatched individuals.

Width across eyes 12; length 32; width across widest portion of abdomen 14. Antennae four-segmented, the segments in the proportions I:II:III:IV::2.5:3.5:3:8.5.

Second Instar—(Fig. 3, Plate V). Antennae, legs and dorsal portion of head as well as spots on thorax, genitals, stink glands darker than in first instar. Eyes reddish at outer border but darker towards interior. Orange and reddish lines on abdomen darker.

Width across eyes 18; length 58; width across widest portion of abdomen 32. Antennal segments as 4:7:6:11.

Third Instar—(Fig. 4, Plate V). Nymph darker than in two previous stages. Segment 4 of antennae more prominently darkened towards apex. Forewings distinctly visible and dark brown in color. Spiracles and repugnatorial glands more shiny black. Otherwise the nymph is similar to two previous instars.

Width across eyes .92 mm.; length 4.00 mm.; width at widest portion of abdomen 1.52 mm. Segments of antennae as 5:11:9:17.

Fourth Instar—(Fig. 5, Plate V). Eyes more prominently darkened toward center. Mesothoracic wings reaching to segment 2 of abdomen; metathoracic wings visible along interior margins of them. White area along anterior, posterior and lateral borders of pronotum and around entire abdomen to genitalia more pronounced.

Width across eyes 1.20 mm.; length 4.40 mm.; width across widest portion of abdomen 1.88 mm. which is at segment 4. Antennal segments as 8:15:13:22.

Fifth Instar—(Fig. 6, Plate V). Antennae shiny black except at extreme bases and apices of the segments. Head black except for small areas in front of and behind eyes which have a brownish to orange hue, the former being about the size of the eyes and the latter shaped like a 30-60 triangle and smaller. Dorsal streak on head about 3 times as wide across as the distance across an eye. Eyes darker than in previous instars and concolorous with darker portions of head.

Pronotum orange, a faint streak of white along anterior and posterior margins—in some specimens entirely covered with orange. Two large brownish-black spots to each side of center line of pronotum which vary in size with the specimens examined but are as long as segment 1 of antennae and $\frac{1}{2}$ to $\frac{3}{4}$ as wide.

Mesothoracic wings black, reaching to segment 3 of abdomen, the under pair being visible on the inner margin.

Abdomen orange, with two lighter streaks to each side of center line; genital area, spiracles, repugnatory openings, and legs, black.

Width across eyes 1.64 mm.; length 6.82 mm.; width at widest portion of abdomen 3.80 mm. (segment 4). Antennal segments as 13:27:20:30.

Adult—Elongate and oblong. Black and red with pale margins on the margins of the membrane and white spots on the disk in some individuals; on others these are entirely lacking.

Clavus black. Prominent red spot on the vertex of the head. Front lobe of pronotum entirely black; hind lobe with a broad red band across the middle. Corium reddish except for an irregular black spot behind the middle and reaching almost to the margin. Scutellum, sterna, antennae and legs black. Abdomen red. Two rows of black spots are evident along the middle and another at the margin of each side of the abdomen. Genital plates and sixth abdominal segment black. Rostrum reaches coxae. Side margins of pronotum rounded. Transverse elevation is visible in front of the middle of the scutellum.

Width across eyes 1.72 mm.; length 8.00–11.50 mm.; width 4.00 mm. Antennal segments in the proportion as I: II: III: IV:: 16: 37: 28: 33.

COLOR MARKINGS.

Early in the course of this investigation considerable variation was noticed in the color of the nymphs. The coloration often varied from gray to bright red. It was also noticed that both the eastern and western forms of *Lygaeus kalmii* occurred in approximately equal numbers throughout the State of Iowa. One thousand specimens were counted at random in the field at several localities in the State and it was found that 49% were distinctly of the eastern type, 49% distinctly of the western type and 2% questionable.

In the laboratory virgin females of each form were mated with males of like coloring and observations made of the resulting offspring during their entire development. A second generation (F_1) was reared from typical specimens of each form and observations were made on these offspring.

Five pairs of adults of each form were placed together in a large cage supplied with food and water, and allowed to reproduce unmolested.

From data accumulated in the manner described above the following results were obtained.

Eastern forms (no spots on membrane) produced 83 individuals, 71 of which were entirely without spots, 10 with a faint spot and 2 with distinct spots on the membrane.

The F_2 generation from unmarked eastern forms produced 20 adults all of which were unmarked.

Western form (2 distinct spots on membrane) produced 63 individuals all with distinct spots. The F_2 generation produced 74

distinctly spotted specimens and 1 with faint spots. An F₃ group showed 47 typical and 3 with faint spots.

Adults of the two forms will interbreed freely in the rearing cages, producing a variety of intermediate forms in addition to distinct types.

PARASITES.

During July and August, 1935, approximately 80 per cent of the adults of *Lygaeus kalmii* collected in the field were parasitized by a Tachinid fly belonging to the genus *Leucostoma*. As a result of this the adults of *kalmii* became quite scarce, and during early September were rather difficult to find. Several hundred eggs collected from the field at various times of the year were hatched in the laboratory in an effort to rear egg parasites. However, none were found at any time.

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